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(71) Applicant
Otting International Inc.,

(Incorporated in USA-Georgia),

411 McLemore Street, LaFayette, Georgia, United States of America

(72) Inventors
Billy J. Otting,
David L. Otting,
Robert B. Putney

(74) Agent and/or Address for Service
M'Caw & Co., 41-51 Royal Exchange, Cross Street, Manchester M2 7BD

(54) Method and apparatus for metering and mixing liquid dyes

(57) A method and apparatus for acurately metering and mixing liquids e.g. textile dyes, by drawing controlled amounts of component liquids of the mixture from respective supply tanks (12a-12e) and then to a mixing tank (16a, 16b). The respective liquid is metered by a reciprocably driven plunger in cylinder (22), the quantity of liquid drawn into and forced out of the cylinder being controllably determined by adjustable stroke reversal apparatus including a switching element (112) disposed on a traveler (90) adjustably positioned by means of a stepping motor (104), the switching element (112) providing a signal for closing an intake valve (34a) and opening an output valve (34b) when the plunger has moved to effect the signal. Another signal is generated when the plunger (24) reaches the head end of the fluid cylinder to open the input valve (34a) and close the exhaust valve (34b). The plunger is driven by pistons of pneumatic cylinders (40, 42) via a connecting yoke; mixture may be mixed in one tank (16a) whilst finished dye is taken from the other tank (16b) for use via valve (18).

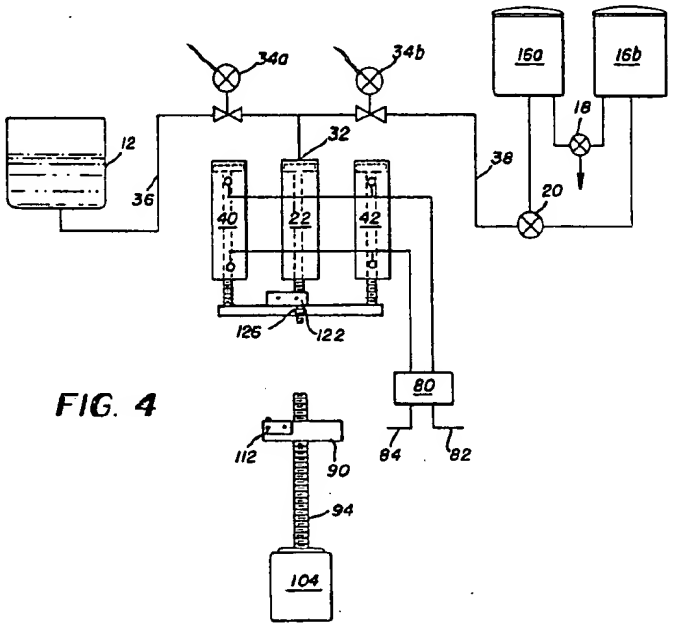

FIG. 4

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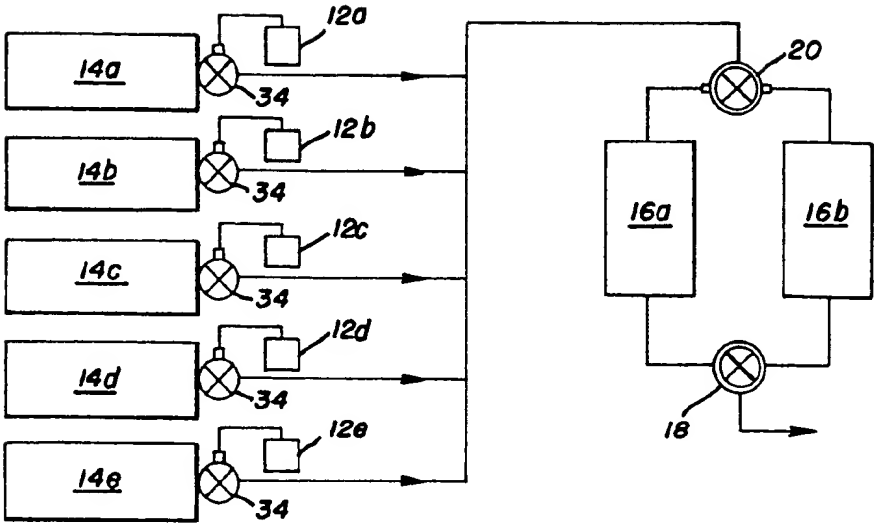
14a
14b
14c
14d
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12a
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12d
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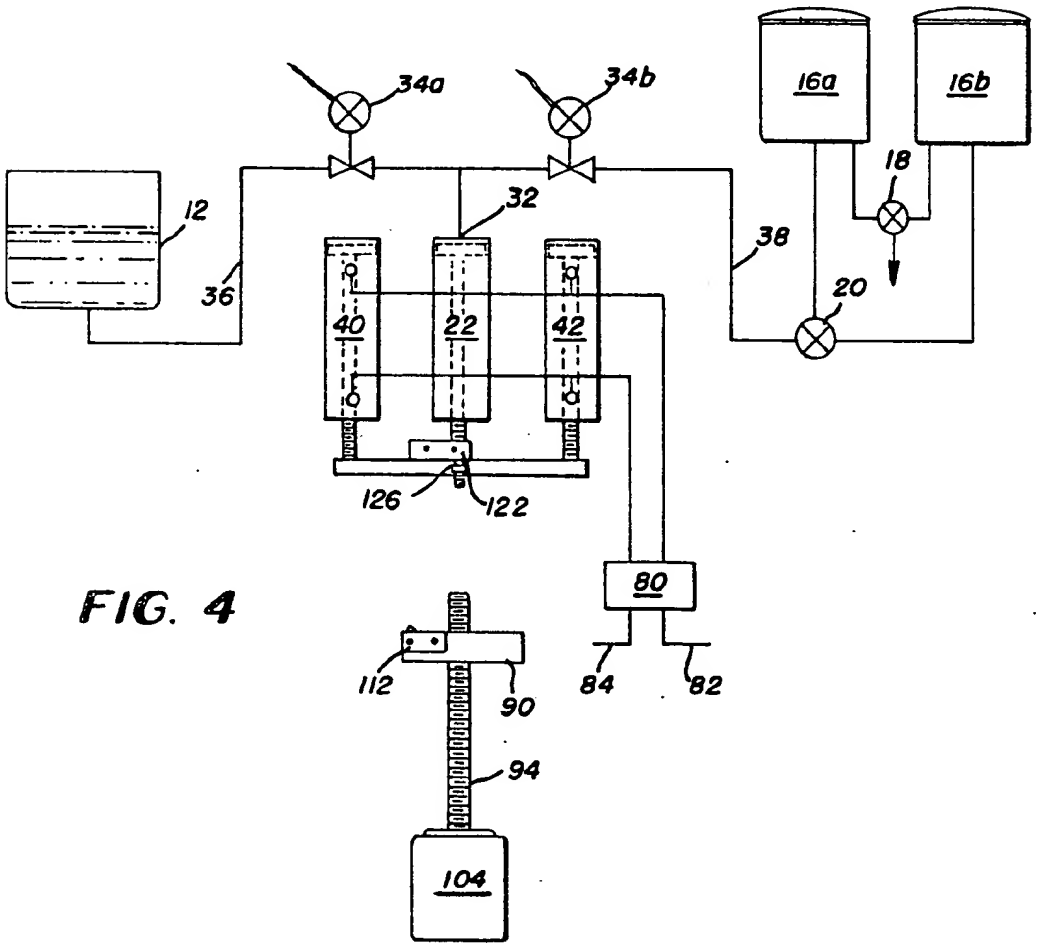
34
20
16a
16b
18

FIG. 1


34a
34b
16a
16b
18
12
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36
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40
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126
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112
90
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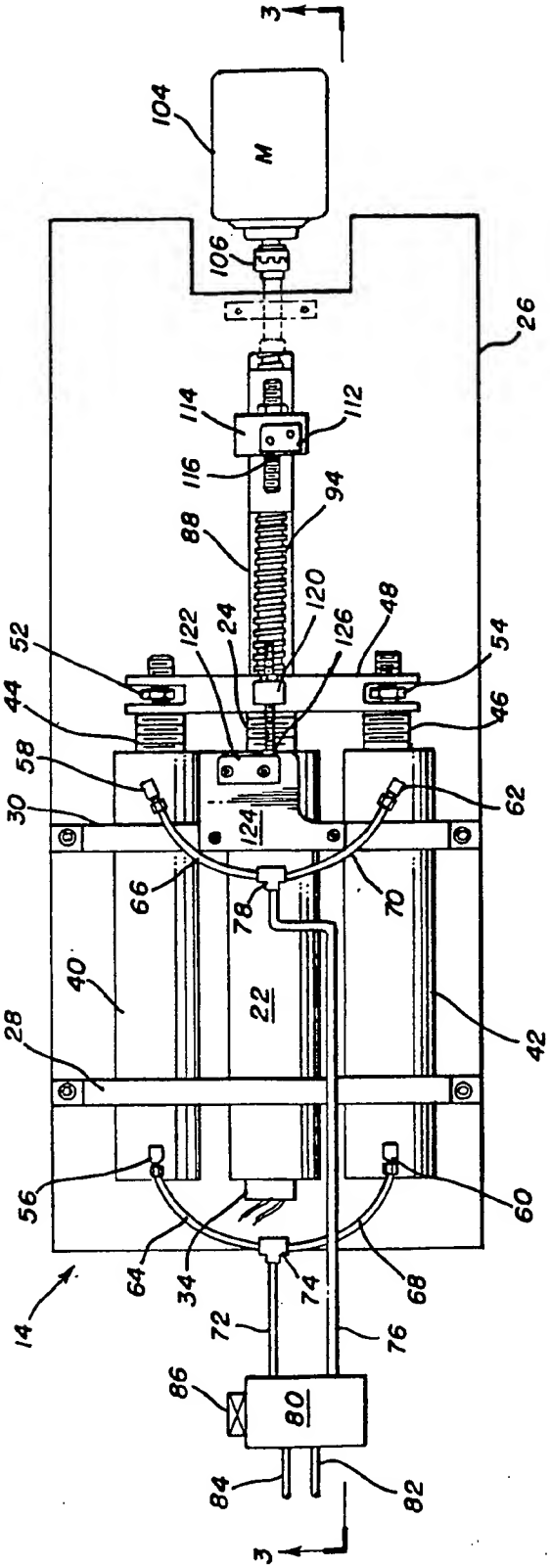
94
104

FIG. 4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124
66
78
70
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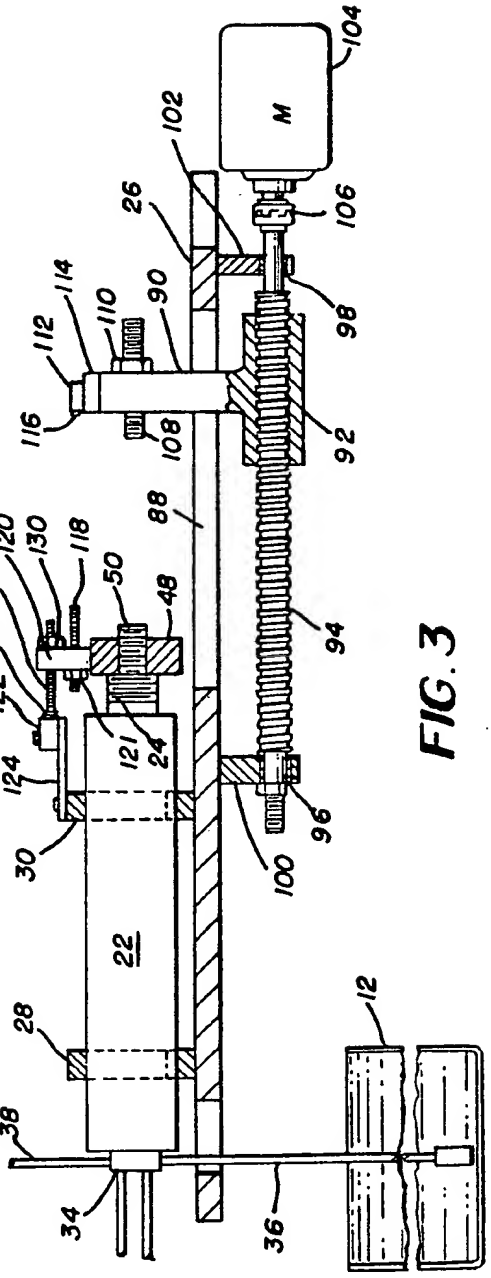
3

FIG. 2


104
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26
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120
130
118
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48
94
126
122
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124
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100
22
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12
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FIG. 3

SPECIFICATION

Method and apparatus for metering and mixing liquid dyes

Background of the invention

This invention relates to the continuous controlled metering of a plurality of liquids and mixing the metered liquids, and more particularly to a method and apparatus for continuously and accurately metering and mixing primary color dyes to obtain repeatable color shades.

In the dyeing of textile fabrics such as carpeting it is important to attain repeatability of color shades from a first run or lot to subsequent runs or lots. Each shade comprises a mixture of at least two of the primary colors such as red, yellow and blue together with a required amount of water and certain chemicals such as those containing acids. Unless the exact amount of each component is mixed together for each shade, variations occur from run to run. In the manufacture of carpets, for example, where a large number of color shades are marketed, a first color shade may not again be run for some time, there being numerous different shades that are dyed between such runs of the same shade. Thus, if a particular shade is mixed in such quantity for use in a first dye run and in later runs, the mixture has to be stored for a substantial time after the first run before it may be used again. This creates a number of problems. For example, the dye and chemical mixture decay with time and not only does color shade variations occur, but the dyeing capability itself becomes less effective. Moreover, storage of such mixtures would require a substantial amount of space, and in certain instances, if a shade loses popularity, such mixtures may not again be required for use. Consequently, the dyes and chemicals are not mixed until needed. This too results in difficulties if sufficient quantity of a run is not mixed, and if too much is mixed a substantial amount of waste may result.

The primary dye colors are marketed in large containers such as 55 gallon drums. When a particular shade is required the mill or dye house mixes appropriate amounts of the dye, water and chemicals as aforesaid. The amounts dispensed for the mixture are generally made on a weight basis, and substantial variations in shade may thus result from time to time taking into account the skill of those responsible for measuring and mixing such quantities.

Attempts have been made in the prior art directed toward continuous mixing of such components to obtain a dye shade and dispensing the same during a carpet run. To date no known practical system has been developed. Certain of the known proposals have used color metering orifices but such orifices become clogged with contaminents which are generally present in the dyes – especially where the dyes have been stored for some time. Of course, as soon as one orifice begins to clog, shade variations commence and the results are obviously unsatisfactory.

Summary of the invention

Consequently, it is a primary object of the present invention to provide a method and apparatus for the accurate continuous metering and dispensing of controlled amounts of a plurality of liquids and the continuous mixing of such metered liquids.

It is another object of the present invention to provide a method and apparatus for metering and dispensing of the liquid components of a liquid mixture for forming said mixture continuously.

It is a further object of the present invention to provide a method and apparatus for continuously mixing the components of a liquid dye to obtain precise color shades, the components being metered and dispensed in a continuous manner to the mixture.

It is a still further object of the present invention to provide apparatus for siphoning accurately and controlled amounts of a plurality of various liquids selectively and dispensing said liquids to a mixing tank for preparing a solution thereof in a continuous mixing process.

It is a yet further object of the present invention to provide apparatus for continuously drawing selected amounts of primary color liquid dyes and other liquid components required for a mixture having a given shade of a color dye from respective component supply chambers and dispensing and combining the liquid components into a chamber having a mixed solution thereof.

Accordingly, the present invention provides apparatus for accurately metering and mixing liquids by drawing controlled amounts of a plurality of liquids from respective supply tanks and feeding the liquids so obtained to a mixing tank. The amount of each liquid drawn and fed may be individually controlled as required for the respective proportions of the mixed solution. The drawing of the respective liquids is controlled by apparatus which suctions the required quantity and thereafter pumps it to the mixing tank where it is combined with the other components.

The preferred utilization of the invention is in conjunction with the metering of required quantities of primary color dyes and other liquid components required for preparation of dye shades for application to textile products such as carpeting. In this regard the required amounts of the three primary colors together with water and liquid chemicals may be suctioned from respective supply tanks and fed to a holding and mixing tank continuously throughout a dye run. Preferably at least two holding or mixing tanks may be utilized and while the dye shade components are supplied to and mixed in one tank the dye supplied to the dyeing apparatus is withdrawn from another tank.

In the preferred form of the invention the respective liquid is metered by a reciprocably driven plunger operating within a cylindrical housing, the plunger drawing a quantity of the liquid into the housing during an intake stroke and forcing the liquid out during an output stroke. The quantity of liquid drawn into and forced out of the housing is determined by the displacement of the plunger

during the intake stroke, and this displacement is controlled by adjustabl stroke reversal means. The housing includes intake and output ports which are selectively opened in response to the direction of movement of the plunger. The means for reversing the stroke of the plunger to thereby control the amount of liquid drawn into the housing by the plunger comprises signal generating means positioned relative to the plunger to provide signals at selected displacement locations of the plunger, the signal generating means at the maximum displacement being selectively advanced and retracted toward the plunger to provide a reversal signal when the plunger has drawn the desired amount of liquid into the housing. Controlled power means controls the stroke reversal locations, the power means driving the plunger alternately in one direction and then in the opposite direction. The power means in the specific form of the invention receives a signal from a switch when the plunger is at the minimum displacement position to drive the plunger out of the housing and receives an alternate signal from a second switch when the plunger is at the maximum desired displacement position to reverse the direction of the plunger after a slight time delay, the latter signal being determined by the location of the second switch. In accordance with an important aspect of the invention the second switch may be selectively drawn to the desired locations in a controlled manner according to the amount of each respective liquid required for the desired solution mixture.

Specifically, the plunger may be driven by fluid driven power cylinders, the working fluid of the cylinders being pumped selectively to alternate ends of the plunger to drive the plunger in the alternate directions. Solenoid valves or the like receive signals from the respective switches to control the flow of the working fluid. The second switch may be mounted on a traveler driven to preselected positions by a controller preprogrammed according to the required amount of the specific liquid in the dye color mixture. The controller in the preferred mode of the invention includes a lead screw on which the traveler may ride and a stepping motor controllably driven to rotate the lead screw and drive the traveler.

Brief description of the drawings

The particular features and advantages of the invention as well as other objects will become apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a schematic view of a five fluid component mixing system constructed in accordance with the principles of the present invention;

Figure 2 is a top plan view of the metering apparatus for one of the fluid components used In the system of Figure 1;

Figure 3 is a vertical cross sectional view of the apparatus taken substantially along line 3-3 Figure 2; and

Figure 4 is a schematic view of the operation of one of the fluid components

Description of the preferred embodiment

Referring now to the drawings, Figure 1 illustrates in schematic form an overview of a five component dye system constructed according to the principles of the present invention. In the system, the three primary color dyes: red,blue and yellow, are mixed with water and an acid chemical and continuously dispense to the dyeing apparatus. Thus, each of the liquid components of the dye includes a respective supply tank 12a, 12b, 12c, 12d, 12e feeding respective liquid metering apparatus 14a, 14b, 14c, 14d, 14e which discharges the metered liquids to mixing tanks 16a, 16b. The liquid dye may be continuously supplied to one of the tanks 16a, 16b and while the dye in that tank is dispensed to the dyeing equipment through a valve 18, the other tank 16a, 16b is supplied with the metered liquids, valve 20 being utilized to select the tank 16a, 16b to which the liquid is supplied. Thus as one tank is being used the other tank is being filled so that color shade mixing is continuous throughout a carpet run.

The metering apparatus for each of the respective components is substantially the same, except for the size – the amount of water being substantially larger than the other fluid components requires larger equipment. Thus, referring to Figures 2 and 3, the metering apparatus 14a, 14b, 14c, 14d, 14e for each component may be described referring to the general layout of one of the components and comprises a metering cylinder 22 within which a plunger or piston is disposed, the plunger having a piston rod 24 extending from one end of the cylinder 22. The cylinder 22 is fastened with its axis of elongation extending horizontally to a support platform 26 by means of clamping brackets 28, 30, each bracket comprising a pair of split members disposed about the cylinder in abutting relationship therewith and secured to the platform at feet on the lower ends of the bottom bracket of each pair. At or adjacent the end of the cylinder 22 remote from the end from which the rod 24 extends is a port 32 for ingress and egress of fluid, the port being illustrated schematically in Figure 4. Valve means 34 is connected to the port 32, such valve means acting to permit ingress of fluid into the cylinder during the suction stroke upon withdrawal of the rod from the cylinder, e.g., movement of the rod and plunger toward the right as illustrated in Figures 2 and 3, and to permit the fluid to be driven out of the cylinder during the power stroke of the plunger, e.g., movement of the rod 24 toward the left in Figures 2 and 3. The valve means 34 includes an Inlet port means connected to a conduit 36 communicating with the fluid in the respective one of the supply tanks 12, and outlet port means connected to another conduit 38 which communicates with the tanks 16 through the valve 20.

The valve means 34 may comprise two separate 2-way valves 34a, 34b as illustrated in Figure 4, each valve preferably being solenoid controlled air valves wherein a solenoid controls an air actuator for controlling the valves. When the valve 34a is open, the valve 34b Is closed and fluid is drawn from the

tank 12 as the plunger siphons fluid from the tank. The valve 34a thereafter closes and the valve 34b opens and the fluid is forced to the tanks 16 during the power stroke. These and other details of the operation of the apparatus will be expanded upon further hereinafter, but for present purposes it may be noted that rather than two separate 2-way valves, the valve means 34 preferably may comprise a single 3-way valve which alternately permits ingress of fluid from the tank 12 into the cylinder 22 while shutting flow to the tanks 16 and then closes flow from the tank 12 as the fluid is pumped from the cylinder 22 to the tanks 16. The 3-way valve may be a solenoid controlled air valve which selectively opens and closes the inlet and outlet ports.

The amount of fluid drawn into the cylinder 22 is determined by the length of the suction stroke of the plunger therein and this stroke is controlled in the present invention by controlling the means for driving the plunger. Preferably the plunger drive means includes at least one and preferably two pneumatic cylinders 40, 42 having respective pistons within the cylinder housing and respective piston rods 44, 46 connected to the pistons and extending from the cylinder. The clamping brackets 28, 30 which secure the cylinder 22 to the platform 26 also act in the same manner to secure the cylinders 40, 42 to the platform. The three plunger or piston rods 24, 44, 46 are connected together for movement as a unit by a yoke connecting member 48, the yoke being threadedly connected to a threaded portion 50 at the end of the rod 24 and secured by nuts 52, 54 on threaded ends of the respective rods 44, 46.

Each cylinder 40, 42 includes a respective pair of ports 56, 58 and 60, 62 for ingress and egress of air selectively. Air conduits or tubes 64, 66, 68, 70 are connected in flow communication with the respective ports 56, 58, 62, the tubes 64 and 68 being connected together and to another conduit or tube 72 by a Tee-connector 74, and the tubes 66 and 70 being connected in a like manner to a conduit or tube 76 by means of another Tee-connector 78. The conduits 72 and 76 are connected to valve means 80 for selectively and alternately supplying air to one end of the cylinders 40, 42 while exhausting air from the opposite end thereof. Thus, valve means 80 is preferably a solenoid operated 4-way air valve to which an air input line 82 and an air exhaust line 84 are connected, the valve being controlled by a solenoid 86 which upon actuation ports inlet air from line 82 to either the tube 72 or the tube 76 while exhausting air from the other of these tubes to the exhaust line 84, and which upon deactuation reverses the direction of air flow from the cylinders 40, 42. The reversal of the valving direction is controlled by means of the solenoid 86 as hereinafter described and determines the direction of movement of the plungers within the cylinders 40, 42 and the direction of the plunger within the cylinder 22 by means of the connection through the yoke 48.

In order to control the amount of fluid drawn into each cylinder 22 from the respective supply tank 12 during the suction stroke and thus the amount of fluid pumped by each cylinder 22 to the mixing and discharge tanks 16, the stroke of the plunger within the cylinder is controlled by controlling the reversal signals supplied to the solenoid 86. To this end, an elongated slot 86 is formed in the platform 26, the slot extending substantially in the axial direction of movement of the piston rod 24. An adjustable traveler member 90 extends upwardly through the slot for longitudinal movement therein, the traveler 90 having a threaded member 92 on the lower end thereof disposed beneath the platform 26. An elongated lead screw 94 is received in the member 92. The lead screw 94 is mounted beneath the platform supported adjacent ends thereof in respective bearings 96, 98 carried by respective bearing blocks 100, 102 extending downwardly from the bottom of the platform 26 beyond the longitudinal terminal ends of the slot 88. One end of the lead screw 94 is connected to a stepping motor 104 by means of a coupling 106 so that upon rotation of the lead screw 94 by means of the stepping motor 104 the traveler 90 may be selectively positioned for reasons which will hereinafter become clear.

Threadedly disposed in the traveler 90 substantially in axial alignment with the end 50 of the piston rod 24 is a stop member 108 which may be adjusted within the traveler and secured therein by a lock nut 110. A limit switch in the form of a microswitch 112 is fastened on a spacer plate 114 secured to the top of the traveler 90 with its contact 116 axially aligned with an operator in the form of a threaded rod or the like 118 adjustably received in a contact block 120 fastened to the top of the yoke 48, the operator being secured in its adjusted position in the block 120 by a lock nut 121. The dispositions of the operator 118 and the stop member 108 is such that the operator 118 engages and closes the contact 116 just prior to the end 50 of the rod 24 engaging the end of the stop member 108 so that the switch may be closed without damaging the components. The operation of the system when the switch 112 is closed will be subsequently described hereinafter. Another limit switch in the form of a microswitch 122 is mounted on a support bracket 124 secured to the top of the clamp 30 and has its contact 126 facing toward the contact 128. Another operator in the form of a threaded rod or the like 120 is adjustably received in the block 120 in axial alignment with the contact 126 for engagement therewith, the operator being adjustably secured in the block by a lock nut 130. The disposition of the switch 122 and the operator 128 are such that the contact 126 is engaged by the operator 128 when the plunger within the cylinder 22 is substantially at the end of its power stroke.

The operation of the apparatus for each fluid component may be described with particular reference to Figure 4. Prior to commencing a run for a particular shade of color, a controller (not illustrated), which may be a micro-computer or the like which can be programed to select the amount of each fluid component for the various shades, signals the stepping motor 104 to locate the position of the carriage 90 so as to select the length of the stroke of the plunger within each cylinder 22, the controller also selecting the number of strokes each plunger within the respective cylinder 22 is to make in order

to provide the desired shade. Moreover, the controller may select the partricular tank 16a or 16b to which the component fluids are to be alternately pumped by providing appropriate signals to the valve 20 and may control the valve 18. Thus, once the stepping motor 104 rotates the required number of turns and positions the traveler 90, the microswitch 112 is located to limit the suction stroke of the plunger.

Commencing with the plunger of the cylinder 22 at the head end of the cylinder, i.e., at the left end in Figures 2 and 3, a signal is fed by the controller to either the solenoids of the two 2-way valves 34a, 34b (or the solenoid of a single 3-way valve 34) to open valve 34a and close valve 34b, thereby communicating the fluid in the supply tank 12 with the head end of the cylinder 22 and closing communication with the tanks 16. The solenoid 86 of the valve 80 is provided with an initial signal to port air from inlet line 82 through the air valve 80 and into the line 72 and thus into the head end of the cylinders 40 and 42, while opening communication from the tail ends of the cylinders 40 and 42 with the exhaust line 84. The pistons in the cylinders 40, 42 are thereby driven away from the head ends of the cylinders and, by means of the yoke 48, draw the plunger of the cylinder 22 in the same direction. The suction created by the plunger draws fluid from the tank 12, which is under a slight positive pressure, through the conduit 36 and valve 34a into the cylinder 22. When the operator 118 engages the contact 116 of the switch 112, and the end 50 of the rod 24 engages the stop member 108, the stroke of the plunger is terminated. At this point a slight time delay of approximately 50 to 100 milliseconds begins before the valve 34a is closed and the valve 80 is reversed, so as to eliminate vaporization of liquid as it is drawn into the cylinder. This ensures that the required amount of liquid is drawn into the cylinder thereby providing that the accuracy of the system is at a maximum.

At the end of the time delay, the valve 34a is closed, and the valve 34b is opened, the valve 34b not opening until positive closure of the valve 34a occurs. Substantially simultaneously with the closing of the valve 34a, the solenoid 86 reverses the porting of the valve 80 so that air in the head end of the cylinders 40 and 42 is ported to the exhaust line 84, while the inlet line 82 is ported to the tail end of the cylinders 40, 42 through the lines 76 and 66, 70. This results in the pistons within the respective cylinder 40, 42 being driven toward the head end of the cylinders and drives the plunger within the cylinder 22 in its power or discharge stroke forcing the fluid within the cylinder 22 out through the valve 34b to the selected one of the mixing tanks 16a, 16b.

At the end of the power or discharge stroke of the cylinder 22, the plunger within the cylinder can move no further toward the head end of the cylinder 22 and the operator 128 engages the contact 126 of the switch 122. This signals the valve 34b to close and thereafter open the valve 34a, while also signalling the solenoid 36 to reverse the porting of the valve 80. The apparatus is then ready to repeat the cycle until the controller shuts the operation of the apparatus for that particular fluid component. The apparatus for the other fluid components may continue to run until they too are shut. For example, by positioning the traveler 90 for the various components (5 with regard to dye shades as aforesaid) at the various locations such that the required amount of each component is metered for the same number of strokes of each respective cylinder 22, the system may run continuously as needed to alternately fill the tanks 16a, 16b selectively during an entire dye run. Alternatively, the apparatus for some of fluid components may run longer than others to obtain the desired proportions of the components held and mixed in one of the tanks 16a, 16b. In either case, the liquid is mixed in one of the tanks 16a, 16b while it is used from the other tank so that complete mixing occurs before the dye is used from a particular one of the tanks.

Although the system is disclosed with particular reference to a dye mixing system, it should have application in other fields. The invention is adaptable to any system where liquids must be metered acurately and mixed. For example, where beverages comprising various liquid components are mixed or where various liquid components of medical preparations are mixed, apparatus according to the present invention may be utilized.

Numerous alterations of the structure herein disclosed will suggest themselves to those skilled in the art. However, it is to be understood that the present disclosure relates to the preferred embodiment of the invention which is for purposes of illustration only and not to be construed as a limitation of the invention. All such modifications which do not depart from the spirit of the invention are intended to be included within the scope of the appended claims.

CLAIMS

1. Apparatus for continuously metering and mixing a plurality of liquids, the liquids being drawn from respective supply tanks and fed to a mixing tank, said apparatus comprising a fluid cylinder corresponding to a respective liquid, each cylinder having a reciprocable plunger disposed therein, port means disposed in each cylinder for ingress and egress of fluid into and out of said cylinder, an inlet conduit disposed in flow communication with a respective supply tank, a discharge conduit communicating with said mixing tank, valve means communicating said inlet conduit and said discharge conduit with said port means for opening passage of fluid from said supply tank into said cylinder while closing passage of fluid to said mixing tank upon movement of said plunger in a first direction and for opening passage of fluid from said cylinder to said mixing tank while closing passage of fluid from said supply tank upon movement of said plunger in a second direction opp site said first direction, drive means for driving said plunger in said first direction and in said second direction alternately selectively, and adjustable means for controlling the drive means for limiting the stroke of said plunger in said first direction and thus limiting the amount of fluid drawn into and discharged from said cylinder.

2. Apparatus as recited in claim 1, wherein said adjustable means comprises a traveler spaced from said cylinder toward said first direction, means for selectively positioning said traveler relative to said cylinder, first signal generating means carried by said traveler and operatively engageable by said drive means for controlling the stroke of said cylinder.

3. Apparatus as recited in claim 2, wherein said first signal generating means controls said valve means for opening passage of fluid from said cylinder to said mixing tank and closing passage of fluid from said supply tank.

4. Apparatus as recited in claim 2 or 3, including second signal generating means responsive to said plunger when said plunger is substantially fully disposed in said second direction for controlling said valve means to open passage of fluid from said supply tank into said cylinder and for closing passage of fluid to said mixing tank.

5. Apparatus as recited in claim 1, wherein said drive means comprises at least one pneumatic cylinder having a piston reciprocably disposed therein, means for connecting said piston and said plunger for movement as a unit, said pneumatic cylinder having a port adjacent each end thereof, control means for directing pressurized air to the port adjacent one end while exhausting air from the port adjacent the other end for driving said piston and said plunger in said first direction and for thereafter directing pressurized air to the port adjacent said other end while exhausting air from the port adjacent said one end for driving said piston and said plunger in said second direction.

6. Apparatus as recited in claim 5, wherein said adjustable means comprises a traveler spaced from said fluid cylinder in said first direction, means for selectively positioning said traveler relative to said fluid cylinder, first signal generating means carried by said traveler and operatively engageable by said drive means for controlling the stroke of said fluid cylinder.

7. Apparatus as recited in claim 6, wherein said first signal generating means controls said valve means for opening passage of fluid from said cylinder to said mixing tank and closing passage of fluid from said supply tank, and for signalling said control means for directing pressurized air to the port adjacent said other end while exhausting air from the port adjacent said one end of said pneumatic cylinder.

8. Apparatus as recited in claim 6 or 7, including second signal generating means responsive to said plunger when said plunger is substantially fully disposed in said second direction for controlling said valve means to open passage of fluid from supply tank into said cylinder and for closing passage of fluid to said mixing tank and for controlling said control means for directing pressurized air to the port adjacent said one end whil exhaustlng air from the port adjacent said other end.

9. Apparatus as recited in claim 8, wherein said control means comprises a 4-way solenoid actuated valve and said first and second signal generating means comprises switch means operatively connected to said solenoid actuated valve.

10. Apparatus as recited in any one of claims 6 through 8, wherein said means for sel ctively positioning said traveler compris s a st pping motor.

11. Apparatus as recited in claim 10, wherein said means for positioning said traveler includes a lead screw operatively connected to said traveler, and means connecting said stepping motor to said lead screw.

12. Apparatus as recited in any one of the preceding claims, wherein said valve means closes passage of fluid from said supply tank to said fluid cylinder prior to opening passage of fluid from said fluid cylinder to said mixing tank.

13. A method for continuously metering a controlled quantity of a first liquid from a supply tank and mixing said first liquid with a plurality of other liquids in a mixing tank to obtain a desired mixture of the liquids, said method comprising drawing said first liquid through an open first valve member into a first end of a fluid cylinder having a plunger disposed therein by pulling said plunger in a first direction from an initial position adjacent said first end toward the other end of said cylinder, stopping the movement of said plunger in said first direction and providing a first signal when said plunger reaches a selected disposition corresponding to the desired quantity of liquid drawn into said cylinder, subsequently closing said first valve member and opening a second valve member communicating said first end of said cylinder with said mixing tank in response to said signal, driving said plunger in the direction opposite to said first direction to force the quantity of liquid within said cylinder out said cylinder through said second valve member to said mixing tank, providing a second signal when said plunger is at said initial position and closing said second valve member and opening said first valve member in response to said second signal, and repeating the cycle.

14. The method as recited in claim 13, wherein said first liquid and said other liquids comprise liquid components of a shade of liquid dye.

15. The method as recited in claim 14, wherein all the components of said dye are metered in the same manner as said first liquid, the quantity of each component being selectively determined to provide said shade.

16. The method as recited in any one of claims 13 through 15 including a time delay in response to said first signal intermediate the stopping of the movement of said plunger in said first direction and the closing of said first valve member.

17. The method as recited in any one of claims 13 through 16, wherein at least one pneumatic cylinder having a piston disposed therein is provided and said plunger is connected to said piston, the steps of pulling and driving said plunger comprising, directing pressurized air to one end of said pneumatic cylinder while exhausting air from the other end thereof to drive said piston in said first direction and thereafter exhausting air from said one end while directing pressurized air into said other end to drive said piston in the opposite direction to

said first direction.

18. The method as recited in claim 17, wherein said exhausting of air from said one end and directing pressurized air to said other end occurs in response to said first signal, and said directing of air to said one end and exhausting of air from the other end occurs in response to said second signal.

19. Apparatus for continuously metering and mixing a plurality of liquids substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

20. The method of continuously metering a controlled quantity of a first liquid from a supply tank and mixing said first liquid with a plurality other liquids in a mixing tank to obtain a desired mixture of the liquids substantially as hereinbefore described with reference to and as illustrated in the various figures of the accompanying drawings.

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